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CT-Scan Evaluation of Acute Pulmonary Embolism: About 63 Thoracic CT-Angiographies at the Rock Medical Imaging Center (CIMR/Kinshasa)

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Abstract

Background and objective: Pulmonary embolism (PE) is a serious pathology with high mortality. The clinical signs of pulmonary embolism are not very specific. Thoracic CT-angiography is the examination of choice in confirming the diagnosis of PE. Our objective was to describe the epidemiological-clinical, tomographic and progressive aspects of patients. *Methods*: A single-center descriptive and analytical observational study of a series of 63 patients received at the CIMR over a period of 24 months. *Results*: The incidence of acute pulmonary embolism was 25.6%. The average age of the patients was 66.5 ± 9.3 years with a F/M sex ratio of 1.6. Most patients had a PESI score ranging from I to III (31.8%, 28.6%, 19.1%). All patients with non-massive PE were stable, while 2 patients with massive PE (37.5%) died ($p = 0.001$). The Qanadli score (QS) was higher in the deceased (64.5% ± 2.1%) compared to the living (46% ± 11.8%) ($p = 0.0313$). The mean LV of patients with massive embolism was low compared to patients with non-massive embolism ($p = 0.005$). The pulmonary artery which was larger in patients with massive embolism ($p = 0.007$) compared to patients with non-massive embolism. The same for the aorta ($p = 0.035$). The RV/LV ratio was higher in patients with massive PE compared to stable patients (1.7 vs 1.1 $p = 0.001$).

The sensitivity of an RV/LV ratio > 1 for the occurrence of massive PE was 91% with a specificity of 59%. *Conclusion*: The frequency of pulmonary embolism on CT-scan is high in our environment. The QS is high while the mean LV diameters of patients with massive embolism are low. The measurement of the pulmonary artery and aorta is greater in patients with massive embolism.

Subject Areas

Radiology, Medical Imaging, Internal Medicine

Keywords

Qanadli Score, Pulmonary Embolism, CT-Scan Thoracic, CT-Angiography, Kinshasa

1. Introduction

Pulmonary embolism (PE) is defined as total or partial obliteration of the trunk of the pulmonary artery or one of its branches by a circulating foreign body, most often fibrinocruoric [1]. It is a serious pathology, since mortality would be 30% without treatment and 2% to 8% with treatment. Massive pulmonary embolisms represent a small proportion and are defined by their association with a state of shock; their early mortality is very high. Its diagnosis is being improved thanks to significant advances in medical technologies. This is a common pathology whose incidence increases with age. The prevalence of pulmonary embolism in autopsies of hospitalized patients is 12% - 15% [2] [3] [4] [5].

In the West, the frequency of pulmonary embolism was 100,000 per year, as in many other European countries [6]. The incidence in Western populations would be between 0.5 and 1 per thousand. In Sub-Saharan Africa overall, the prevalence of PE varies between 1.4% and 7% depending on the study [7] [8]. The management of massive pulmonary embolisms, from a diagnostic point of view, requires the use of the most recent imaging techniques, in particular CT angiography, and cardiac Doppler echo for the urgent establishment of adequate treatment [9]. Furthermore, the diagnostic performance of a CT examination for pulmonary embolism is inseparable from the performance parameters. Because elementary technical knowledge makes it possible, in fact, to deduce the diagnostic possibilities and limits of the examination. This concerns in particular the choice of acquisition, injection, reconstruction and irradiation techniques. The differential diagnoses of PE are also very dependent on the technique which is very little operator-dependent but which remains machine-dependent [8] [9] [10]. Pulmonary embolism is potentially serious, its mortality is high. It is recognized that the clinical signs of pulmonary embolism are not very specific, so that PE can be part of the differential diagnosis of many conditions [8] [9] [10]. It is still not easy to obtain a confirmatory diagnosis. Currently several wellcodified clinical strategies can guide additional examinations. Also, the treatment of pulmonary embolism is prolonged and relies on the use of anticoagulants with the disadvantages of increased bleeding risk. It is therefore necessary to obtain a definitive diagnosis to begin treatment. Several Western studies [11] and the sub-region [12] have reported that multi-slice thoracic CT angiography is the examination of choice in confirming the diagnosis of PE [7]-[12]. However, the experience of Congolese authors is not sufficiently reported with regard to the DRC. It is in this context that we initiated this study which helps to identify CT pulmonary embolism and describe the severity assessment parameters with a view to contributing to the improvement of the management of this pathological entity in our country.

2. Materials and Methods

2.1. Nature and Period of the Study

This was a single-center descriptive and analytical observational study of a series of cases received at the ROCHER Medical Imaging Center (CIMR) in Kinshasa over a period of 24 months, going from January 2019 to January 2021 and coming from emergency department of Saint Joseph Hospital in Kinshasa.

2.2. Population and Sampling

The population of this study consisted of any adult patient consulting the emergency department of Saint Joseph Hospital and having performed an AST for suspected pulmonary embolism during the study period at the CIMR imaging department.

Inclusion criteria: Adult patients presenting to the emergency department of the Saint Joseph hospital in Kinshasa and having benefited from a chest CT-angiography at the CIMR, whatever the indication, but by which a diagnosis of EPA could be confirmed, were included. *Non-inclusion criteria*: An AST with chronic PE, A normal AST.

2.3. Variables of Interest

2.3.1. General Characteristics

Sociodemographic; (age and sex); *Comorbidities* (progressive cancer, chronic heart failure, coexistence of DVT); Survival (alive or death); the PESI score.

2.3.2. CT-Scan Data

Several possible prognostic criteria were collected; four criteria relating to the impact on the right heart chambers, one criterion concerning the embolic load and one criterion concerning a complication.

- The RV/LV ratio: the diameters of the RV and LV were measures in short axis, thanks to multiplanar reconstructions; the measurement was made between the inner wall of the edge ventricular free and the interventricular septum, at the distal 2/3 junction.

- The RV/LV ratio was in disfavor of a RV dysfunction if it was less than 1, and in favor if he was greater than 1. The diameter of the trunk of the artery pulmonary on an axial section, just Before its bifurcation. A diameter of the AP greater than 29 mm was considered as pathological. Shape of the interventricular septum: the SIV was classified not deviated, *i.e.*, deviated. When he was deviated, he was either rectilinear (verticalized septum, *i.e.*, bulging in the LV (inverted septum.
- The presence or absence of contrast product reflux into the IVC or VSH. This was a qualitative criterion, indirectly testifying to the overload of the VD. Embolic load: the Qanadli index, expressed as a percentage, was measured for each patient. The arterial tree of each lung is considered to be composed of 10 segmental arteries: 3 in the upper lobes, 2 in the middle lobe or lingula, and 5 in the lower lobes. The presence of an embolus in a segmental artery counts 1 point, and an embolus in a proximal artery counts according to the number of segmental arteries downstream. To best estimate the residual perfusion, a weighting factor is used for each assigned point: 0 if there is no defect, 1 if it is a partial occlusion, and 2 if the occlusion is complete. An isolated embolus of a subsegmental artery is considered a partial occlusion of the upstream segmental artery and counts as 1 point.
- Presence or not of pulmonary infarction: when pulmonary condensation with a pleural base was present in a vascular sector affected by pulmonary embolism, the scan was considered positive for infarction. Evaluation of image quality by measuring the density of the artery trunk pulmonary (Nazaroglu): 199 HU or less, enhancement limit; quality average; from 200 to 249 HU, acceptable enhancement; quality good; of 250 HU or more, excellent enhancement, quality excellent.

2.3.3. Collection of Data

Medical data concerning each patient were collected from medical records. All CT-scan examinations were carried out on a 16-slice scanner (Somatom FORCE, Siemens Healthcare, Forchheim, Germany, manufactured in 2005) which has been in service for 6 years. The protocol presented below is routinely practiced in this department in adults after preparation made by exclusion of contraindication factors to the use of an iodized contrast product. A CT scan with contrast injection was performed after the injection of 100 ml of omnipaque 350 mg at a rate of 3.5 to 4.0 ml/s during a series without injection. After an injection-scan delay of 4 to 28 seconds as determined by the bolus tracking software, sonographic angiography was obtained at 120 kVp, 300 to 400 mA. Collimation was 0.5 mm with reconstruction of 1.25 to 2.0 mm. Rotation time was 0.3 to 0.5 seconds and table speed 7.5 mm/rotation.

2.3.4. Interpretation of the CT-Angiography and Judgment Criteria

The scans were interpreted a second time to obtain all the study criteria by a 4th year medical imaging assistant, using PACS. The reading was taken in the pulmonary parenchymal window and in the mediastinal window. For the judgement criteria, the primary endpoint was hemodynamic severity of PE (presence of massive PE) and the secondary endpoint was 30-day mortality.

2.4. Ethical Considerations

Ethical and benevolent principles were observed. The use of the results of the present study was limited to the strict exploitation related to the objective of the study. The protocol of our study was presented to the ethics local committee and we obtained a favorable opinion.

2.5. Data Processing and Analysis

For the statistical analysis, a value of $p < 0.05$ was retained as significant for the interpretation of the results. The quantitative data were compared by ANOVA analysis of covariance then two-by-two student test. The normality of the distributions was checked using the Shapiro-Wilk test. The quantitative data were then compared by Student's t test and were correlated using Spearman's correlation. Qualitative data were studied using Fisher's exact test. All statistics were carried out using SPSS software version 21.0 for Windows. Equation of the linear regression line: $y = 0.6953x + 8.0679$.

3. Results

3.1. Characteristics of Patients with Massive PE Compared to Patients with Non-Massive PE

From 2019 to 2021, the Le Rocher imaging department received 246 patients with suspected PE coming from the HSJ emergency department, among whom 63 had an acute pulmonary embolism on CT-angiography (25.6%). Most patients had no morbid history or risk factors. Of a total of 63 patients, 55 presented with non-massive embolism (87.3%), while two patients died (3.2%). The average Qanadli score was 46.6% ± 12%, or lower in 73.1% of cases. The mean age of patients with massive pulmonary embolism was similar to that of patients with non-massive pulmonary embolism as were many women and men. All patients with non-massive pulmonary embolism were stable (alive), while 2 patients with massive pulmonary embolism died. The majority of patients with massive pulmonary embolism had a history of thromboembolic disease as a risk factor in a higher proportion compared to patients with non-massive embolism. According to the PESI score, classes IV and V were most frequently found in patients with massive pulmonary embolism, while classes I, II and III were found in patients with non-massive pulmonary embolism (Table 1).

3.2. CT-Scan Data of Patients with Massive PE Compared to Patients with Non-Massive PE

The Qanadli score was on average higher (57.6 ± 12) in patients with massive embolism compared to patients with non-massive embolism (45 ± 11.2), the comparison of proportions showed a statistically significant difference (p =

0.005). On the other hand, when comparing the averages of the mean LV diameters, the average of patients with massive embolism was low compared to patients with non-massive embolism (p = 0.005). Unlike the pulmonary artery measurement which was larger in patients with massive embolism (p = 0.007) compared to patients with non-massive embolism. The same for the measurement of the aorta (p = 0.035) (Table 2).

3.3. General Characteristics of Deceased Patients and Living Patients

Of a total of 63 patients followed in our study, 2 died, representing a mortality of 3.2%. Below, Table 3 provides us with information on the general characteristics of patients according to survival. Deceased patients were older than living patients (p = 0.0392). A history of DVT and heart failure was found in 50% of these patients, respectively. They were both classified V according to the PESI score. While living patients had a PESI score ranging from I to III in 32.8%, 29.5%, and 19.7% respectively. Most of them had no history (49.5%) or risk factors (62.3%). (Table 3).

Table 1. Baseline of patients with massive PE compared to patients with non-massive PE.

VARIABLES	Massive pulmonary embolism	Non-massive pulmonary embolism	p
Average age (year)	66.5 ± 9.3	65.8 ± 8.6	0.062
Sex			0.355
Man	4 (50)	20 (36.4)	
Women	4 (50)	35 (63.6)	
Survival:			0.001
Number of living patients	5 (62.5)	55 (100)	
Number of patients who died	2 (37.5)	0	
Clinical comorbidities:			0.067
Progressive cancer	3 (37.5)	25 (45.5)	
Coexistence of a DVT	1 (12.5)	5 (9,1)	
Chronic heart failure	1 (12.5)	0	
Risk factors:			0.024
Antecedent of surgery	1 (12.5)	5 (9,1)	
MTEV	5 (62.5)	14 (25.5)	
PESI score:			0.000
Class I	0	20 (36.4)	
Class II	0	18 (32.7)	
Class III	0	12 (21.8)	
Class IV	3 (37.5)	5 (9,1)	
Class V	5	0	

*Standard deviation.

Table 2. CT-scan data of patients with massive PE compared to patients with non-massive PE.

Variables		Massive pulmonary embolism		Non-massive pulmonary embolism		
		n = 8 (%)	Mean ± SD	n = 55 (%)	Mean ± SD	p
Technical quality	Excellent	3 (37.5)	-	30 (54.6)	-	0.061
	Good	3 (37.5)	-	17 (30.9)	-	-
	Average	2 (25)	-	8 (14.5)	-	-
Qanadli Score		-	57.6 ± 12		45 ± 11.2	0.005
	≥60%	5 (62.5)	-	12 (21.8)	-	-
	≤60%	3 (37.5)	-	43 (78.2)	-	-
Ventricular measurement (mm)	Average RV diameter	-	35.9 ± 3.4		39.8 ± 5.4	0.061
Diameter medium VG		-	32.8 ± 2.9		38.5 ± 5.4	0.005
	Greater than 1	7 (87.5)	-	22 (40)	-	-
	Less than 1	1 (12.5)	-	33 (60)	-	-
	AP	-	33 ± 3.3		29.4 ± 3.4	0.007
	Number of AP > 29 mm	7 (87.5)	-	26 (47.3)	-	-
	Aorta measurement	-	35.6 ± 3.7		32.4 ± 3.9	0.035
	Interventricular septum	-	-		-	-
	Not deviated	2 (25)	-	39 (70.9)	-	-
	Of life	6 (75)	-	16 (29.1)	-	-
	Not deviated	2 (25)	-	39 (70.9)	-	-
	Verticalized	5 (62)	-	8 (14.6)	-	-
	Reverse	1 (12)	-	8	-	-
	Reflux into the IVC or VSH	6 (75)	-	16 (29.1)	-	-
	Pulmonary infarction	4 (50)	-	13 (23.6)	-	-

Table 3. General characteristics of deceased patients and living patients.

VARIABLES		Alive		Death	
		n = 61 (%)	Mean ± SD*	n = 2 (%)	p
Sex	Male	24 (39.3)	-	0	
	Feminine	37 (60.7)	-	2 (100)	
Age (years)			55 ± 10		0.0392
Type of embolism	Massive	6 (9.8)	-	2 (100)	
	Non-massive	55 (90.2)	-	0	

Continued

Clinical comorbidities	None	28 (49.5)	-	0
	Progressive cancers	28 (49.5)	-	0
	Coexistence of a DVT	5 (8)	-	1 (50)
	Chronic heart failure	0	-	1 (50)
Risk factors	None	38 (62.3)	-	0
	Story of surgery	5 (8.2)	-	1 (50)
	MTEV	18 (29.5)	-	1 (50)
PESI score	Class I	20 (32.8)		0
	Class II	18 (29.5)		0
	Class III	12 (19.7)	-	0
	Class IV	8 (13.1)		0
	Class V	3 (4,9)		2 (100)

*standard deviation.

3.4. CT Characteristics of Deceased and Living Patients

Out Qanadli score was higher in deceased patients (64.5% ± 2.1%) compared to living patients (46% ± 11.8%). All deceased patients had a Qanadli score greater than or equal to 60% with a statistically significant difference (p = 0.0313). These patients had a larger diameter pulmonary artery (36.3 ± 5.4) compared to the deceased patients (29.7 ± 3.3) with a statistically significant difference (p = 0.0085). The mean RV diameter of deceased patients was higher compared to living patients (p = 0.0384). While the average LV in living patients was higher in the living than in the deceased (p = 0.213). The RV/LV ratio was higher in patients with massive PE compared to stable patients (1.7 versus 1.1 p = 0.001). The sensitivity of an RV/LV ratio >1 for the occurrence of massive PE was 91% with a specificity of 59% (**Table 4**).

4. Discussion

4.1. Incidence of Pulmonary Embolism

In our 4-year series, 246, including 63, had acute pulmonary embolism on CT. The incidence of acute pulmonary embolism in this population is therefore 25.6%. Our rate is close to the numerous rates reported in the majority of studies, which is around 25% [13] and even up to 62% in the study by Nural *et al.* [14].

Indeed, the latest European recommendations have highlighted spiral pulmonary angiography in the diagnostic but also prognostic strategy for PE [15]. Due to advances in imaging, certain anomalies (dilatation of the right cavities and paradoxical septum) can also be visualized with a multi-slice scanner, and the aim of our work is to study their prognostic nature. Indeed, valvular flows, the analysis of which is done by ultrasound and which cannot be studied directly on CT angiography (in particular tricuspid insufficiency), have little place for the prognosis of the EP at present [15].

Table 4. CT characteristics of deceased and living patients.

VARIABLES		Alive		Death		p
		n = 61 (%)	Mean ± SD*	n = 2 (%)	Mean ± SD*	
Technical quality	Excellent	32 (52.5)	-	1 (50)	-	-
	Good	20 (32.8)	-	0	-	-
	Average	9 (14.7)	-	1 (50)	-	-
Qanadli score (%)		-	46 ± 11.8		64.5 ± 2.1	0.0313
Qanadli Score	≥60%	15 (24.6)	-	2 (100)	-	-
	≥60%	46 (75.4)	-	0	-	-
Ventricular measurement (mm)	Average RV diameter	-	39.6 ± 5.3		31.7 ± 1.5	0.0384
	Diameter medium VG	-	38.1 ± 5.3		29.2 ± 1.3	0.0213
RV/LV ratio	Greater than 1	27 (44.3)	-	2 (100)	-	-
	Less than 1	34 (55.7)	-	0	-	-
Pulmonary artery measurement		-	29.7 ± 3.3		36.3 ± 5.4	0.0085
Number of AP > 29 mm		31 (50.8)	-	2 (100)	-	-
Aorta measurement		-	32.6 ± 3.9		38.3 ± 0.1	0.0448
Interventricular septum	Deviated septum	41 (67.2)	-	0	-	-
	Deviated septum	20 (32.8)	-	2 (100)	-	-
	Verticalized septum	11 (18)	-	2 (100)	-	-
	Reverse septum	9 (14.8)	-	0	-	-
Reflux into the IVC or VSH		20 (32.8)	-	2 (100)	-	-
Presence of a heart attack pulmonary		16 (26.2)	-	1 (50)	-	-

4.2. Main Features

In our series, the mean age of patients with massive pulmonary embolism was similar to that of patients with non-massive pulmonary embolism (p = 0.062) as much as the number of women and men. The average age of the patients was 66.5 ± 9.3 years with a F/M sex ratio of 1.6. Our results are similar to those reported by Bounameaux *et al.* [16]. Not only is age a risk factor for PE, it is reported in the literature that several factors for PE occur with age. In our series, the majority of patients with massive pulmonary embolism had a history of thromboembolism as a risk factor in a higher proportion compared to patients with non-massive embolism (p = 0.024) in whom the average age was statically higher. According to the PESI score, classes IV and V were most frequently found in patients with massive pulmonary embolism, while classes I, II and III were found in patients with non-massive pulmonary embolism (p = 0.000). Note that this score becomes pejorative with age.

4.3. PE Mortality Rate

Of a total of 63 patients followed in our study, 2 died, representing a mortality of

3.2%. Deceased patients were older than living patients (p = 0.0392). A history of DVT and heart failure was found in 50% of these patients, respectively. They were both classified V according to the PESI score. While living patients had a PESI score ranging from I to III in 32.8%, 29.5%, and 19.7% respectively. Most of them had no history (49.5%) or risk factors (62.3%).

Qanadli score was higher in deceased patients (64.5% ± 2.1%) compared to living patients (46% ± 11.8%). All deceased patients had a Qanadli score greater than or equal to 60% with a statistically significant difference (p = 0.0313). These patients had a larger diameter pulmonary artery (36.3 ± 5.4) compared to the deceased patients (29.7 ± 3.3) with a statistically significant difference (p = 0.0085). The mean RV diameter of deceased patients was higher compared to living patients (p = 0.0384). While the average LV in living patients was higher in the living than in the deceased (p = 0.213).

In fact, hospital mortality from pulmonary embolism is of the order of 10% [16] [17] [18] [19], but this figure varies significantly depending on the area concerned and hemodynamic tolerance, but also depending on the authors. PE-related deaths most often occur within an hour of the onset of symptoms: 2/3 of patients with massive PE will die within this time, according to Wood *et al.* [17]. This delay was verified in our study, the 2 deaths occurred among patients with massive PE, a few hours after their arrival in the emergency room.

4.4. Prognostic Factors for PE Clinical Prognostic Criteria (PESI)

The PESI score another severity score based on exclusively clinical elements was developed by Aujesky [17], with 30-day mortality as the endpoint: the Pulmonary Embolism Severity Index (PESI). It was developed retrospectively from a large North American hospital registry and was subject to internal validation and external validations in various independent, particularly European, cohorts [17] [18]. The score increases with age, male gender, number of comorbidities and clinical abnormalities. The patients are divided into five classes, and mortality increases from class I to V. It is of the order of 2.5% in classes I and II, it is 7% in class III, 11% in class IV and 24% in class V. In our series, according to the PESI score, classes IV and V were most commonly found in patients with massive pulmonary embolism, while classes I, II and III were found in patients with non-massive pulmonary embolism (p = 0.000). Note that this score becomes pejorative with age.

4.5. CT-Scan Prognostic Criteria

The RV/LV ratio: The RV/LV ratio was higher in patients with massive PE compared to stable patients (1.7 versus 1.1 p = 0.001). The sensitivity of an RV/LV ratio > 1 for the occurrence of massive PE was 91% with a specificity of 59%. In the study by Mbozo'o *et al.* [20] 11.11% of pulmonary embolisms were severe, *i.e.*, an RV/LV ratio > 1.5. A pulmonary artery trunk diameter value greater than 27.5 mm was correlated with an RV/LV ratio > 1 (Sensitivity: 73%, Specificity: 77%). This author reports that the lethality of pulmonary embolism was correlated with an RV/LV ratio greater than 1.5 (Sensitivity = 100%, Specificity = 98%). Indeed, according to the new recommendations of the European Society of Cardiology published in 2008, the severity criteria for a pulmonary embolism are as follows: RV/LV ratio greater than 1.5 which is a reflection of right ventricular dysfunction and Diameter of the pulmonary artery and TAP/Aorta ratio greater than 1 [15].

Due to advances in imaging, certain anomalies (dilatation of the right cavities and paradoxical septum) can also be visualized on a multi-slice scanner, and the aim of our work is to study their prognostic nature. Indeed, valvular flows, the analysis of which is done by ultrasound and which cannot be studied directly on CT angiography (in particular tricuspid insufficiency), have little place for the prognosis of the EP at present. The parameters studied on ultrasound for the prognosis of PE can therefore technically be replaced by a CT study. The latter indirectly evaluates right ventricular dysfunction by measuring the RV/LV ratio, the presence or absence of a paradoxical septum, or the presence of contrast product reflux in the IVC and VSH. Its prognostic evaluation would be all the more interesting as it is the reference examination for the diagnosis of PE; all patients therefore benefit from it, unless there is a contraindication. CT signs of right ventricular dysfunction: Signs of right ventricular dysfunction have been validated on echocardiography as being interesting prognostic markers. With advances in imaging, these signs can be transposed to CT, and this is all the more interesting as this examination is the gold standard for the diagnosis of PE. A single examination therefore makes it possible to make the diagnosis and stratify the prognostic risk of patients with PE. Indirect evaluation of right heart function (ratio of RV/LV diameters in short axis section, position of the interventricular septum, blood reflux in the IVC or VSH, size of the pulmonary artery), direct pulmonary ischemic complications of the PE (presence of a pulmonary infarction), and the vascular obstruction index can be interesting prognostic markers, and are easy to assess on a CT angiogram.

The increase in the RV/LV ratio and the deformation of the interventricular septum, assessed by echocardiography, have been known for a long time for their short-term prognostic value in PE, and numerous studies have shown their equivalence as a prognostic value. to the scanner. Two studies, by Lim *et al.* [18] showed that the signs of right ventricular failure on CT, defined by an RV/LV ratio > 1 or a bulging of the interventricular septum, had a sensitivity between 78% and 92%, a specificity of 100%, and a value 100% positive predictive using transthoracic echocardiography as a reference examination. The scanner therefore seems reliable in detecting these signs, it is correlated with ultrasound for the detection of signs of right ventricular failure. The scanner is more interesting, especially since the measurements to be carried out are easy, quick, and reproducible, and the diagnosis and prognosis are carried out in a single examination in current practice. Arterial Obstruction Score: The Qanadli score was on average higher (57.6 ± 12) in patients with massive embolism compared to patients with non-massive embolism (45 ± 11.2), the comparison of proportions showed a statistically significant difference (p = 0.005). Comparison of mean RV diameters did not show a statistically significant difference. On the other hand, when comparing the averages of the mean LV diameters, the average of patients with massive embolism was low compared to patients with non-massive embolism (p = 0.005).

Unlike the pulmonary artery measurement which was larger in patients with massive embolism (p = 0.007) compared to patients with non-massive embolism. The same for the measurement of the aorta (p = 0.035).

In our study, the Qanadli score was on average higher (57.6 ± 12) in patients with massive embolism compared to patients with non-massive embolism (45 ± 11.2), the comparison of proportions showed a statistically significant difference (p = 0.005). Indeed, the diagnosis of PE previously relied on pulmonary angiography, and, among the vascular obstruction scores calculated to quantify the importance of the embolism, that of Miller was widely used. PE was considered serious from 50% - 60% vascular obstruction. Mansencal *et al.* [21] show a good correlation between the degree of vascular obstruction on angiography (using the Miller score) and the impact on the right cavities defined by an RV/LV ratio > 0.6 in apical 4-chamber ultrasound section. But this link was not found with the measurements on parasternal long axis sections: on these sections, the dilation of the right cavities was not correlated with vascular obstruction. Mansencal *et al.* [21] therefore showed the existence of a link between RV dilation and embolic load of the EP only on 4-chamber ultrasound sections. The literature is quite discordant regarding the link between the importance of PE according to vascular obstruction scores and clinical outcome, but this may be due to very different study populations. Some studies find a correlation between early mortality and the importance of the embolic load on CT-scan, others not, but the embolic load is nevertheless higher in hemodynamically unstable patients than in stable patients: obstruction scores vascular scans would therefore be good indicators of the clinical severity of PE. The Mastora score focuses on vessels up to the division's segments, and the Qanadli score to the subsegmental arteries. Furthermore, these scores do not take into account the underlying situation, in particular chronic respiratory insufficiency, already responsible for an increase in pulmonary resistance.

5. Limitations of Study

Our study includes the small sample size. Also, we have not included all the necessary clinical, biological and ultrasound parameters which would have allowed a better evaluation of the technique studied in this work.

6. Conclusion

Thoracic CT-angiography stands out as a complete examination, allowing comprehensive patient care, both diagnostic and prognostic, in a single step. Our study shows that it specially makes it possible to distinguish hemodynamically serious PE from non-serious ones; it is therefore well correlated with the clinic. Three markers of the hemodynamic severity of PE were highlighted in our center: the Qanadli vascular obstruction score, the RV/LV ratio, and the deviation of the interventricular septum. On the other hand, the diameter of the PA, the coexistence of a DVT, the presence of reflux of contrast product in the IVC, or of a pulmonary infarction, were not correlated with the hemodynamic severity of the EP.

Additional Information

Disclosures

All authors have confirmed that this study did not involve animal subjects or tissue.

Contribution of Authors

All authors confirmed having participated.

Conflicts of Interest

The authors declare no conflicts of interest.

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Principles' Abbreviations

AP: *Artery pulmonary*
CIMR: *The Rock Medical Imaging Center* (*for Centre d'Imagerie Médicale Le Rocher*)
CT: *computed tomography*
DVT: *deep vein thrombosis*
IVC: *Inferior Vena Cava*
LV: *Left Ventricular*
MTEV: *Venous thromboembolism*; (*for Maladie thromboembolique veineuse*)
PACS: *Picture Archiving and Communication System*
PESI: *Pulmonary Embolism severity index*
PE: *Pulmonary embolism*
RV: *Right Ventricular*
VSH: *supra-hepatic vein*